The Present State of Meteorology.

ART. III.—The Present State of Meteorology.

BY R. L. J. ELLERY, ESQ., F.R.S., F.R.A.S.

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THE desirability of increasing our knowledge concerning the weather, and more especially with the view of securing some amount of prescience on meteorology, is, I believe, generally admitted; and few will for a moment question the propriety of expending labour, pains, and money, if thereby the more important changes of weather could be predicted with certainty a few days in advance, or if reasonable premonition of climatic vicissitudes—such as rains, droughts, excessive heat, or cold—could be deduced from the discussion of past and present meteorological observations. Assuming this much, then, I purpose to refer briefly to what has been and is being done towards these ends, and with what probability of success and usefulness to the world.

Although the systematic meteorological observations and investigations of the physical laws dominating the changes and movements of the earth's atmosphere have occupied the attention of physicists and observers in past times, it is only within the last few years, comparatively speaking, that the subject has been grappled with comprehensively and scientifically. The tentative essay at prediction and forecast on scientific principles which has been made in Europe and America are matters almost of to-day, and must be considered as yet only "feeling its way." It is true we have had from time to time, from Murphy downwards, weather systems propounded, weather predictions a year in advance, and almanacs printed with a prediction allotted to each day; a lucky coincidence or two enlists the belief of the ignorant for a time, but that great teacher, experience, eventually relegates all these spurious systems to the limbo of fools. The truly scientific meteorologist knows the difficulty of the matter, and how little has yet been made light which will enable him to predict with confidence what weather will prevail in any one locality a

few hours ahead, and will at once admit his inability to deal with the facts of meteorology as he would with those of any of the physical sciences.

Attempts have also been made, upon scientific grounds, to deduce from a discussion of seasonal mean temperature the probable characteristics of coming seasons; to ascertain if there be a periodicity in climatic vicissitudes, as well as to generalise in other ways from past experience. As an instance of these attempts, I may refer to the very clever and exhaustive paper by my friend and co-labourer, Mr. H. C. Russell, of Sydney, given to the Royal Society of New South Wales, entitled "Meteorological Periodicity;" but while this paper is one of the most valuable extant for reference on the subject of Australian meteorology, it clearly indicates the apparent hopelessness of any such attempt in our present state of knowledge, and certainly no satisfactory results have been deduced from the other investigations referred to.

Almost every civilised country at the present time is provided with a principal meteorological observatory or observing station, generally assisted by various other stations of more or less importance, according to position or instrumental appliances, either wholly or partly supported by public money. Besides these there are always numerous careful and energetic private observers, who voluntarily furnish the central observatory with the results of their work. I know of no country or place of importance where settlement and civilisation have reached from whence meteorological records cannot be obtained; and if one can judge of the extent to which meteorological facts have been collected from the piles upon piles of manuscript records at the Melbourne Observatory, not only from these colonies, but from various regions of the broad ocean, from desolate islands and other places, leaving alone the weary number of volumes, sheets, and pamphlets which arrive from other countries, I think I am perfectly safe in saying that in no branch of inquiry has such an enormous amount of statistics been collected as in meteorology.

Now one of the chief, if not the chief, object in instituting meteorological observations in any country at the public cost, may be assumed to be climatology—for economic, sanitary, and, perhaps most of all, for agricultural purposes; to ascertain by a long extended series of observations the range of temperature, rainfall, movements of air, &c., to which the particular country may be subject. The broader aspect of the question is, as a rule, a secondary consideration—to be desired, but too extensive to be grappled with by observations extending only over a limited area; and so, while the accumulating records gradually serve the more immediate climatological requirements, they are laid by or are printed and disseminated. Except for the sake of criticism, these printed observations are only referred to occasionally by the student, writer, or traveller; and although there is now and then something said of the desirability of dealing with this enormous collection of facts, I think that about a thousand Keplers would be wanted for the task.

It will not be denied, however, that for local requirements some systematically conducted meteorological research is necessary and valuable in all civilised communities, more especially in countries like Australia, depending largely on agricultural and pastoral interests, as well as maritime commerce, and subject to the climatic vicissitudes which so often prevail. Assuming this, it will not be unprofitable to inquire how the observations can best be made in Australia to serve all the more immediate and local requirements, and at the same time assist in the general scheme of investigating the laws which govern the earth's atmosphere generally.

Before doing this, I would briefly indicate what is being attempted in other countries. The United States of America certainly stand in front as far as regards the magnitude and system of meteorological research, and the results obtained. The vast land-tracks in the U.S. over which meteorological observing stations have been extended have made possible in that country a system which few other nations could attempt. Provided with almost unlimited means, and the assistance of a whole army of military men as observers, the signal service of the United States has been enabled to meteorologically blockade a large portion of the continent. Aided by all the facility that can be conferred by a network of telegraph' lines where priority and promptitude of despatch is insisted upon and given, the American meteorological system is undoubtedly the most complete in the world. The principal outcome of this great scheme is the issuing of daily weather charts and bulletins showing the meteorological conditions all over the States, and the publication of forecasts or "probabilities" (as they are called)

of the weather a day or two ahead, indicating the track and intensity of marked disturbances, or the approach of fine weather. It is stated that over 80 per cent. of these predictions are realised, and if that be so, the result will not be so incommensurate with the magnitude and cost of the system as might at first be imagined. It is to be hoped, however, that in this magnificent undertaking some of the higher meteorological problems may be attempted and solved; and it is not unworthy of remark that General Myer, the director of this service, has enlisted the co-operation of nearly all the meteorological observatories in the world in obtaining simultaneous observations—that is, the meteorological conditions in force at each station at one definite time, that time being forty-three minutes after noon, Greenwich mean time.

From inquiries made during my late visit to Europe, I ascertained that 250,000 dols. was the annual vote for the American signal service, and that that amount included no salaries for observers, all of which come from the military votes. In Great Britain £10,000 is voted annually for meteorological purposes, and the commission of inquiry in its recent report on the department recommended an increase to £14,000 or £15,000.

The meteorological system of Great Britain includes both ocean and land meteorology. The former comprises means for furnishing the necessary instruments, &c., for observation to ships of both the Imperial and mercantile navy, and collecting and tabulating the results; while the latter includes, besides the ordinary systematic observations, a very complete system of weather telegraphy and storm warnings. Every morning, Sundays excepted, telegrams are received from about 50 places, more than half of which are in the British Isles, and the rest in other European countries. These telegrams are immediately discussed, and weather-charts founded on the results are at once published and disseminated. By this means the movements of the atmosphere over Northern Europe and the adjacent ocean become The approach of storms can be generally predicted known. with reasonable certainty, and warning at once given to the threatened coast line by telegrams, which are made widely and rapidly known by the storm-signals and other means. At the same time all the purposes of agricultural meteorology are subserved by the weather-charts, and the carefully prepared bulletins published in the daily papers. While, therefore, the more strictly local and practical requirements are thus admirably served, by reason of the oceanic observations and the widely spread area from which daily telegrams are received, the more theoretical demands from which to deduce information concerning the relations that prevail between the atmospheric movements and conditions in different parts of a considerable portion of the earth's surface are supplied.

France, Belgium, Denmark, Holland, Germany, Sweden, Russia, Austria, and Italy, all co-operate in similar work; but while America and England undoubtedly contribute most liberally, each of the nations mentioned grants State funds for meteorological purposes varying from £500 to £6000 annually. The latter sum, if we take into consideration the value of money and cost of computing power in most of the countries named, would represent an amount equivalent to, if not more than, the annual grant made by the British Parliament.

These brief references will convey a pretty correct notion of what is being done for meteorology in the Western world. I have only to mention that in South America, Cape Colony, India, China, Japan, Mauritius, and other places, systematic observations are made, to show that a pretty round sum must be expended every year for the purpose of recording what the weather has been, with the glimmer of a hope that the power of predicting what it will be may be eventually secured.

The outcome of all this expenditure of money and labour is at present easily summed up. In America it is said, and I do not doubt it, that immense and increasing benefit is conferred on the community by prompt publication of the "probabilities." In Great Britain and Northern Europe most of the dangerous storms are foreseen, and much loss of life and property no doubt prevented; for the rest of the world, with some few exceptions, the results are confined to furnishing climatic statistics generally of mere local interest, the piling up of volume upon volume of books filled with regular readings of instruments and descriptions of atmospheric appearances, which are exchanged between the observatories and scientific institutions of the world, forming so much building material for our future meteorological architects.

It will be evident from what I have already stated that

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meteorological observation holds a prominent place in the world's work, and that there is no niggard contribution from State or other public funds to aid in the undertaking; and while it will also be seen that in addition to the collection of statistics, which are in themselves valuable, a foretaste of what may be hoped for from systematic investigation has been actually realised in both Great Britain and America. it cannot but be admitted that meteorology has not yet become a science. To those who know the difficulty and complexity of the problems involved, this is no matter for surprise. Nevertheless, if, after all the time, money, and labour spent upon observation, and the enormous mass of statistics collected, we are compelled to this conclusion, the question forces itself upon us whether or not the inquiry of nature has been in the right direction, or whether there are not other modes of inquiry necessary to elucidate what the usual modes of observation have as yet failed to do. These questions I cannot pretend to answer. I feel confident. however, that our inquiries must be extended in new directions before further theoretical knowledge can be secured.

The present system of meteorological observation consists in measuring and recording at each particular locality the variations of temperature, pressure, movement, and humidity of the atmosphere, the amount of heat radiated from the sun by day and sent back from the earth into space by night, the amount of water evaporated from the earth's surface, and the amount returned to it in the shape of rain. To these may be added as matters of observation at some places the electric condition of the air, the temperature of the exterior crust of the earth, and the variations of terrestrial magnetism. Although nearly all observers agree that these constitute the orthodox items for observation, they are not at all agreed as to the best methods of obtaining them; there is a diversity of apparatus, different methods of exposure, and different times for observation. Some observations considered of paramount importance in one country are neglected in another, and so on. In order, however, to establish one universal and accordant system, a congress of European meteorologists was formed a few years ago, which has met from time to time at the various cities of Europe to discuss matters connected with this part of the subject. Recommendations have already been issued and co-operation invited by the congress, but the existing

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differences in matters of detail are so numerous and great that it is likely a considerable time will elapse before the congress can hope to succeed in establishing that uniformity of procedure so necessary in meteorology. Most of the observations are made near the surface of the ground, and even in this part of the subject difference of opinion exists : some prefer 4 feet, others 5 feet, 6 feet, 7 feet, or 10 feet, while many physicists attach great importance to the establishment of observatories at considerable altitudes, either on mountain-tops or by means of captive balloons; and there can be little doubt that observations made at altitudes varying from 2000 feet to 10,000 feet would add very materially to meteorological knowledge. Within the last few years, also, the state of the sun's surface has been regarded by many as being in some way connected with climatic variations, as we know it has upon the magnetic conditions of the earth.

I must now say a few words concerning what has been and is being done in Australia in this matter. For many years past meteorological observations of a more or less perfect character have been made in the various colonies. and annual means of temperature, rainfall, &c., deduced. Of later years the number of observing stations has been largely increased, with greatly improved instrumental aid; and many of the questions asked by the public, meteorologists have been able to answer; the chief characteristics of the climate have become known, and some of the laws which govern the movements of many of our atmospheric disturbances have been ascertained. But regarding the great local question of dry and wet seasons, and similar matters of the greatest importance in Australia, we are as ignorant as ever. I have now been intimately connected with Australian meteorology for nearly 25 years, and have gained some experience as to our requirements in that respect, of which I shall have a few words to say presently. At the present moment we have five properly furnished meteorological stations, where observations are made at least three times a day. Four of these are on the coast, three of which are lighthouses. Besides these we get observations once or twice a day made with standard instruments from seven stations, and records of rainfall and state of weather from 23 stations. Most of these are supplied with instruments at the cost of the State, while many observers furnish

returns more or less complete with instruments belonging to themselves.

Some months ago, after my return from Europe, I determined to try and bring our meteorological system into a somewhat better shape. Each colony possessed a pretty complete machinery for first-class observation, and every month, or every year, the printed results were exchanged. My inquiry into the working of the weather telegram system in Europe convinced me that, now all the colonies are connected by telegraph, a similar system, on a smaller scale, could be put into operation here with considerable advantage to the public, especially the maritime portion, and at a very moderate cost. The question had often been discussed between Mr. Todd, of Adelaide, Mr. Russell, of Sydney, and myself, but matters had never appeared ripe until last year, when I formally asked the co-operation of these gentlemen, which was cordially given. Plans of operation were discussed and agreed upon, and in January last a system of Australian weather telegraphy was commenced. This system consisted of the exchange of observations in cypher by telegraph between Adelaide, Melbourne, and Sydney twice a day (Sundays excepted), the observations being those obtained at selected stations furnished with properly tested instruments. The stations were so selected that most of the coast-line along which passes our principal traffic should be represented, as well as districts which may be taken as typical of Central Australia; and with the view of having information of the dip of the monsoons and equatorial currents, stations along the trans-Australian telegraph line, as far north as Port Darwin, were also chosen. The information exchanged is of the usual kind-readings of barometers, thermometers, rain gauges, observations of wind, state of sea, appearance of sky, &c.

The first object in view in establishing this system was to prepare every afternoon a synopsis of the weather and state of the sea along the coast line, and also eventually to issue a weather chart, showing graphically the substance of the weather telegrams. It was intended to publish this information by posting the charts and bulletins at the various telegraph and shipping offices where they were likely to be of value.

The second object hoped for was the increase of knowledge of the meteorology of Australia generally, and additions to the very scant theoretical information we now possess. Up to a certain point this system may be said to be established in Melbourne, but beyond it seems at present somewhat difficult to get, on account of the irregular and unpunctual manner in which the telegrams from the neighbouring colonies come to hand, rendering it impossible to satisfactorily attempt the publication of either weather bulletins or charts. Whether this is owing to defective telegraph arrangements, or a want of appreciation of the importance of the matter on the part of the various Telegraph Departments, I cannot say; but it must be obvious to all who know anything of the matter that unless there be prompt despatch and delivery of weather telegrams, it will be useless to try and make any immediate use of the information for the public benefit. In England, America, Belgium, &c., weather telegrams have precedence of all but pressing State business, as it is well known that without it they would be useless. These difficulties are, however, I hope only temporary, and are almost inevitable at the beginning of all new undertakings. I have good hopes therefore that the system will ripen into a most useful institution. which will, I am sure, be quickly and fully appreciated by the public. It is hoped that Western Australia, Tasmania, and Queensland will before long be included in the scheme; for the two former are, from their position, of great importance, and will increase in no small degree the prospect of further theoretical knowledge.

The meteorological observations comprised in this system leave a large amount of local inquiry unsatisfied, which can, however, I believe, be adequately provided for by a simpler method than is required for Australian weather telegraphy. While the six or seven selected stations in Victoria must be kept in the most efficient working order, with a full supply of instrumental means, local climatology and weather statistics can be furnished by a more numerous class of secondary stations, which should supply a brief daily report by telegraph of the state of weather, wind, temperature, and rainfall, and keep a record of the same, from which the usual monthly and annual means can afterwards be deduced at the Observatory for publication in the meteorological Such stations should be established in every statistics. township of importance, and it is a question whether this might not best be done by the municipal authorities, for it is not at all improbable that they might take sufficient

interest in the matter, simply for the sake of the local information, to provide the necessary instruments and secure the requisite observations.

Our rainfall varies so largely with locality, that in order to obtain trustworthy statistics—so necessary in matters of water supply, drainage, and other public works—a rain gauge should be kept at every police station throughout the country. There are over 300 public barometers on the English coast for the use of fishermen and others, and in Victoria there are seven or eight. A few more of these instruments, if they could be taken care of (which some of those now in position appear not to be), would be advantageous. They are, however, not nearly so much required on our coast as in England.

The eager inquiries from all classes for weather news, especially during our critical seasons, render it desirable to adopt some simple means for furnishing the information sought. This is now done to a considerable extent by the Central Telegraph Office, but threatens to become a too cumbrous tax on that service if it is not systematised. If the localities from which reports are to be received were properly selected, and a simple code adopted, confining the reports to state of wind and weather, rainfall and temperature, omitting barometer readings entirely, a much more comprehensive and comprehensible bulletin of the weather prevailing throughout the colony would be furnished to the public than is now the case, without taxing the Telegraph Department so much as at present. By these means I think all the requirements of a temporary and local character would be fully met, while all the higher and more theoretical questions would be probably better dealt with by confining our attention to a few well-selected and wellequipped stations than by more numerous half-furnished observatories indiscriminately chosen. It is more economical, and more likely to be fruitful. The establishment of a station at a considerable altitude is the only addition to the present scheme that is required, and this I hope to accomplish before long on Mount Macedon, at an elevation of 3000 feet.